Tasmanian Devil: An Application of the High Level Architecture in the Distributed Mission Training Domain

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ABSTRACT: *The Tasmanian Devil project is a cooperative effort by the Defense Modeling and Simulation Office (DMSO), Air Force Research Laboratory Warfighter Training Research Division (AFRL/HEA), and USN Air Combat Environment Test and Evaluation Facility (ACETEF) Aircraft Simulation - Manned Flight Simulator (MFS). The purpose of the project is to gain experience in the application of the HLA in the distributed mission training domain. The multi-service federation development team developed and demonstrated two simple, parallel service federations including aircraft training simulators using a common 2vX air-to-air training event. Each federation implemented a common federation design that was developed over the course of the project using the Federation Execution and Development Process (FEDEP) as a roadmap. Specific project objectives include: 1) implementation of HLA interfaces for the F-16 and F-18 simulators, an ordnance server, and a cockpit radio simulation; 2) beta testing of RTI NG; 3) first use of a VxWorks version RTI; 4) use of same FOM in two federations with two different mixes of federates; 5) use and assessment of agile FOM interfaces; and 6) examination of issues related to an evolutionary and persistent federation. This paper describes the results and lessons learned from the Tasmanian Devil project.*

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1. Background

1.1 Introduction

Tasmanian Devil (nicknamed Taz) is a joint DMSO, AFRL, ACETEF MFS research project aimed at gaining practical experience and insights in the application of the HLA in the distributed mission training domain. The purpose of the project is to provide feedback to the participating service organizations, the DMSO technology programs, and the larger M&S community.

Specifically, AFRL is interested in using the HLA to meet its future distributed mission training requirements. Together, AFRL and ACETEF MFS are interested in how HLA technologies can support joint training for the full range of joint air combat missions and platforms. DMSO, the technology transition agency for M&S in DoD, developed the HLA and supporting tools, software and processes to support the broad DoD M&S community.

Structured around the HLA FEDEP [1], the Tasmanian Devil research explores techniques for implementation of HLA interfaces for manned simulators, federations with mixed operating systems, embedded computers, and different federates, and, finally, issues related to evolutionary and persistent federations.

1.2 Some Definitions

A *persistent federation* and its accompanying *objective FOM* are defined as follows:

- A persistent federation is a collection of specific federates and an objective FOM used by those federates. The objective FOM describes all data that might be exchanged at runtime by any of the federates.
- For any particular execution, any logical subset of the federates and the objective FOM may be used.
- The federation is persistent because the objective FOM and set of federates are used and reused over an extended period of time.

An *evolutionary federation* is defined as follows:

- An evolutionary federation evolves its composition (FOM and federates) over time.
- The evolution must be systematically managed to ensure that the entire federation evolves at the same pace and to ensure that design decisions made early in the life of the federation do not adversely impact overall federation evolution.

These terms are of interest because it is anticipated that future federations in the distributed mission training will be both evolutionary and persistent.

FOM agility is defined as:

- FOM agility is the ability of a federate to readily participate in multiple federations that use differing FOMs.

FOM agility is of interest because, even if the distributed mission training community develops its own persistent, evolutionary federation, there will undoubtedly be requirements to interoperate with other federations in other domains that have different FOMs optimized for their domain. FOM agility may be a mechanism to support cost-effective interoperation with these other domains. Further, FOM agility may also facilitate the evolution process, allowing federates to more easily adapt to the evolving FOM.

1.3 Tasmanian Devil Project Objectives

The following key objectives were established for the Tasmanian Devil project:

- Demonstrate use of the HLA in a high fidelity, warfighter-in-the-loop air-to-air training environment
- Demonstrate VxWorks –based federates operating with federates using other operating systems and RTI ports
- Beta test RTI NG
- Implement native RTI interfaces for some federates[1]
- Gain HLA certification for the federates
- Demonstrate use of the same FOM in two federations with two different mixes of federates
- Use an agile FOM approach
- Assess agile FOM approach
- Provide feedback on HLA, associated HLA tools, concepts and processes
- Address issues of evolutionary persistent federations
- Develop inputs for the FEDEP Checklist [2] for training federations
- Develop follow-on plans

1.4 Research Approach

To accomplish the project objectives the team followed the process depicted in Figure 1. The FEDEP process, a systems engineering process for the complete life-cycle of a HLA federation, was used to guide the team activities. The team executed the FEDEP process as though developing a real-world persistent evolutionary federation

[1] JSAF already had a native HLA interface at project start.

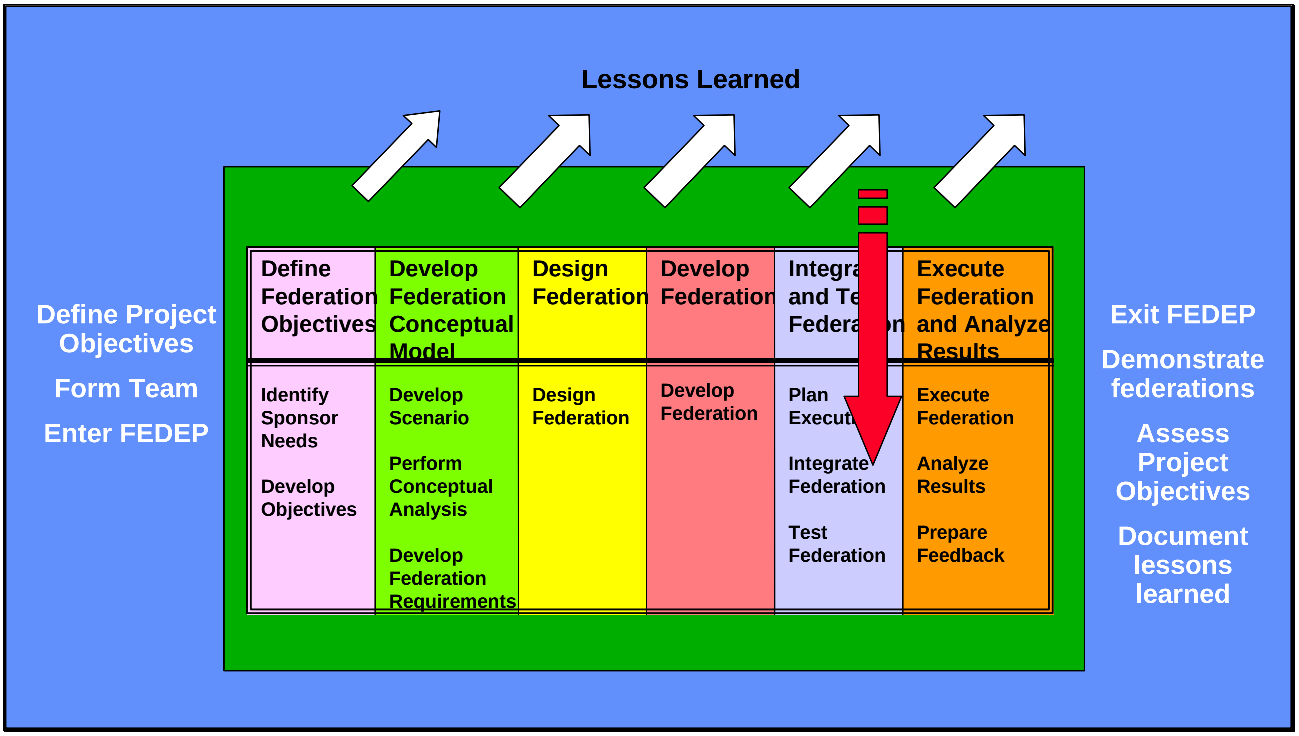

Figure 1. Tasmanian Devil Research Approach

for the distributed mission training community, as opposed to developing a research prototype. This was done so that, to the extent possible, the team would understand and execute the process the community would ultimately follow, and thereby make the lessons learned applicable to that environment. Lessons learned would be collected throughout and a period of assessment would be conducted after the FEDEP was completed.

The project took longer than anticipated and the red arrow on Figure 1 shows the project location in the FEDEP at the time of writing of this paper.

1.5 The Federations

Two prototype federations were developed, depicted in Figure 2. The federations were developed by the entire team in a combined execution of the FEDEP, to support the same training mission, using the same FOM. One federation was integrated and operated at AFRL and was designated Taz-AF. The second was integrated and operated at ACETEF MFS and was designated Taz-Nav.

Taz-AF included two AFRL F-16 cockpit simulators and the AFRL-developed DMT Controller Station (DCS), to provide trainer and technical monitor and control of the federation and playback for after-action review. Taz-Nav included two ACETEF MFS F-18 cockpit simulators and the ACETEF MFS-developed Ordnance Server to represent fly-out of the cockpit missiles.

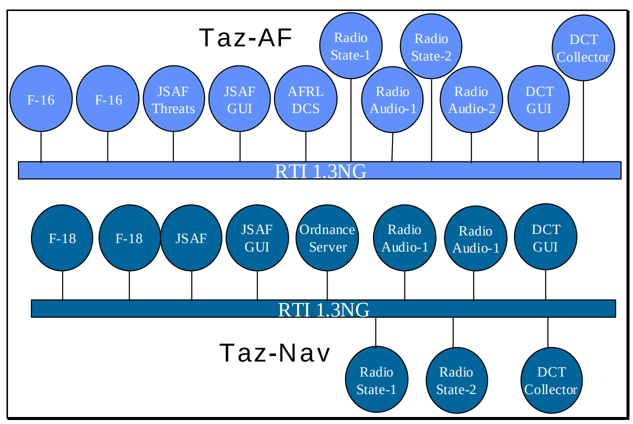

Figure 2. Taz-AF and Taz-Nav

Both federations included

- JSAF for representation of threat aircraft, SAM sites and missiles.
- JSAF graphical user interface, providing a plan view display for the AWACS role player function.
- ASTI radios for communication between cockpit pilots and AWACS role player during execution of the scenario, and to communicate with technical control during setup.

- ASTI radios for technical control and for all simulation operators to facilitate technical management of the federation.
- A beta version of Virtual Technologies Corporation's (VTC) hlaResults™ tool, to collect and analyze data and playback the federation into the JSAF plan view display for after-action review. [2]

1.6 Tasmanian Devil Team

The Tasmanian Devil team consisted of

- ACETEF MFS development team
- AFRL development team
- ASTi development team
- Federation Manager and systems engineering team from The MITRE Corporation, SAIC, and MIT Lincoln Laboratory
- RTI NG support from SAIC
- Data collection, analysis and playback support from VTC
- JSAF Agile FOM Interface support from Lockheed Martin Information Systems
- USAF Aeronautical Systems Center / Training Systems Product Group (ASC/YW)
- USAF Air Combat Command (ACC)
- USAF Air Force Agency for Modeling and Simulation (AFAMS)

1.7 Taz Schedule

The Tasmanian Devil project timelines were very short – approximately seven months. The ACETEF MFS, AFRL and ASTi development teams had limited prior experience with developing HLA applications, and the project required them to both build new native HLA interfaces for their applications and to participate in the design and development of a new federation. The schedule is depicted in Figure 3.

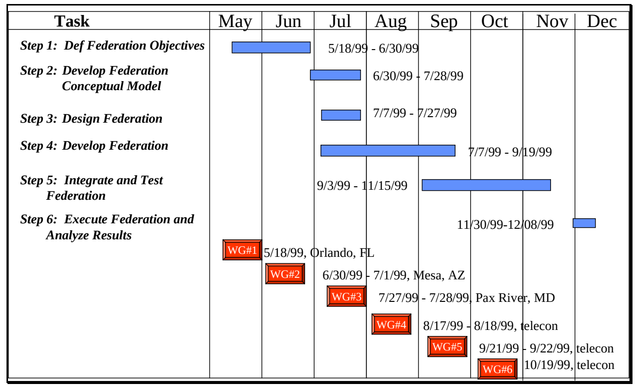

Figure 3. Tasmanian Devil Schedule

1.8 Products and Deliverables

The planned products and deliverables for the Tasmanian Devil project were:

- HLA interfaces for all federates using RTI 1.3NG[3]
- Taz FOM and SOMs in Object Model Library[4]
- Taz-AF and TazNav federation demonstrations
- HLA compliance certification for all federates
- Training domain checklist
- Lessons learned document
- Plan for future industry and other service participation
- Plan for future distributed Taz-joint federation demonstration

2. FEDEP Highlights

While FEDEP execution products or results are presented here in step order, it is important to note that the FEDEP was not executed in lock step order nor once-through. Rather, as each FEDEP step was performed and new information was discovered, previous steps would be re-visited, as needed, in order to ensure product completeness. Please also note that only the first five FEDEP steps were executed due to schedule constraints.

2.1 Step 1: Define Federation Objectives

A federation purpose, a scenario, training objectives, tasks, measures of effectiveness (MOEs), and schedule drivers were identified.

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[2] VTC's hlaResults™ tool was successfully integrated into Taz-Nav but was not demonstrated due to unresolved network problems. The tool will be demonstrated with both Taz-AF and Taz-Nav in Taz-2000.

[3] ASTi self-funded development of their HLA interface and therefore it was not a deliverable to the government

[4] To protect the information, a point of contact, rather than the actual SOMs, is provided for the AFRL SOMs.

2.1.1 Purpose

The purpose of the Tasmanian Devil federations is to provide Air Force and Navy high fidelity, warfighter-in-the-loop, mission-level training for a specific set of air-to-air tasks.

The design perspective used was that the federations are the starting point for a persistent and evolutionary federation capability that will support the full range of joint air combat missions and platforms.

2.1.2 Scenario

ACC defined the basic scenario, which was refined by subject matter experts at AFRL. The scenario is depicted in Figure 4.

2.1.3 Training Objectives, Tasks and MOEs

The training staff at AFRL developed the training objectives, tasks and MOEs. The training objective for the federation is to develop pilot proficiency in performing Defensive Counter Air (DCA) procedures. The specific mission tasks that the pilots must perform to demonstrate proficiency in DCA procedures, and that the federation must therefore support, are:

- Maintain situational awareness.
- Maintain radio discipline.
- Perform CAP management.
- Perform missile management.
- Perform sensor management.
- Perform threat suppression.

Mission- and task-level MOEs that could be collected to verify that the training objectives are met were identified and include both subjective measures assessed by the training staff and objective measures that could be computed from collected federation data. The latter type of MOEs include:

- RED aircraft penetration across Commit and Vulnerability Lines,
- Trainee accuracy (BLUE fires versus RED kills),
- RED kills by trainee, and
- Trainee mission survivability (did the trainee survive the mission).

2.1.4 Schedule Drivers

Schedule drivers were identified as:

- Completion date by 31 December
- Availability of beta version of VxWorks RTI
- Availability of simulators – both AFRL and ACETEF MFS maintain busy lab schedules and, additionally, AFRL planned to ship out their simulators for the Air Force Association Conference in September and I/ITSEC in December.
- Availability of Ordnance Server federate – ACETEF MFS developed a new, C++-based ordnance server in parallel to this effort.
- Availability of DCS – AFRL developed this completely new controller station in parallel to the Tasmanian Devil effort.

To mitigate the risk associated with these schedule drivers, the team agreed to constrain the complexity of the implementation.

2.2 Step 2: Develop Federation Conceptual Model

There were three elements to this step. First the conceptual model of the key events and objects in the virtual battlespace required to meet specific training requirements was defined based on the scenario defined in Step 1.

Next, training requirements were identified. These requirements are that the trainer/evaluator be able to:

- observe the training audience, both in real-time and in playback mode.
- collect data required to compute MOEs and MOPs
- set initial conditions
- alter course of events / inject events

Finally, technical requirements were identified. These requirements are that the technical federation manager be able to:

- monitor federation health
- schedule saves and restores
- coordinate federation synchronizations
- measure federation technical performance (e.g., network bandwidth usage, federate computational workload, etc.)
- control federates (e.g., “SIMAN”-like functions such as pause and resume, turn logging on and off, change simulation time, etc)

2.3 Step 3: Design Federation

This step involved allocation of conceptual model functionality to federates, and the design of features to meet the training and technical requirements.

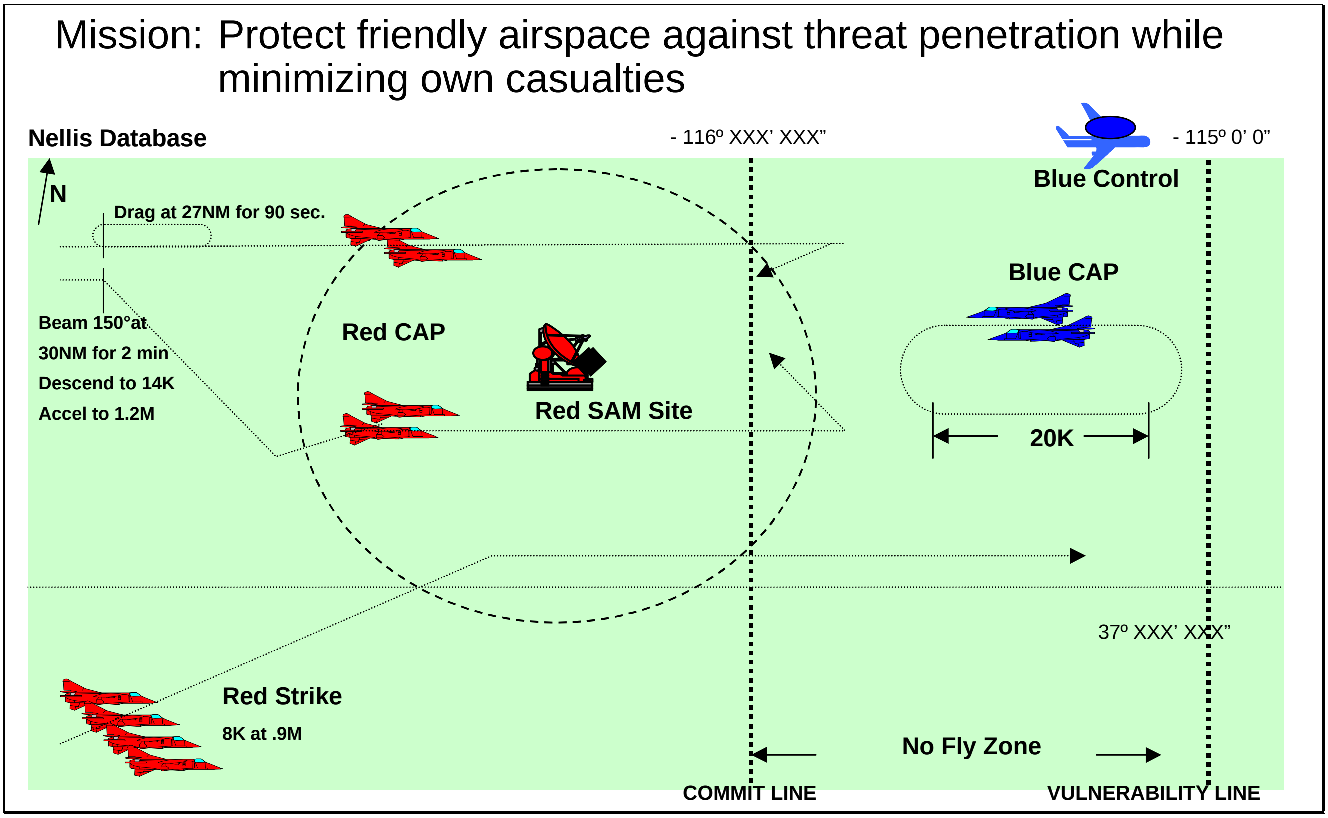

Figure 4. Tasmanian Devil Scenario

2.3.1 Allocation of Conceptual Model Functionality to Federates

The allocation of conceptual model functionality to federates is depicted in Table 1.

Table 1. Allocation of Conceptual Model Functionality to Federates

Functionality	Federate
Blue (AF) F-16 aircraft and Blue AA missiles	AFRL simulators
Blue (Navy) F-18 aircraft	ACETEF MFS simulators
Blue (Navy) AA missiles	ACETEF MFS ordnance server
Red aircraft, Red AA missiles, Red SAM sites, Red C2 ground sites , and SA missiles	JSAF
Blue CAP (AF and Navy) aircraft and Blue Control (AWACS) aircraft radio sets	ASTi radio simulation

2.3.2 Trainer Requirements and Possible Design Solutions

The design alternatives identified by the team to meet trainer requirements are presented in Table 2. Due to schedule and budget constraints, many design solutions were not completely implemented. Alternatives in normal font were implemented, those in bold were partially implemented, and those in italics were not implemented.

2.3.3 Technical Requirements and Possible Design Solutions

The design alternatives identified by the team to meet technical requirements are presented in Table 3. Due to schedule and budget constraints, many design solutions were not completely implemented. Alternatives in normal font were implemented, those in bold were partially implemented, and those in italics were not implemented.

Table 2. Possible Design Solutions for Trainer Requirements

Trainer Requirement	Design Alternative
Generate MOEs and MOPs	• **Extend FOM** • Observe from "god's eye" perspective • Playback plan-view display • Playback video tapes of cockpit HUDs • Playback cockpit HUD video tapes • Interview pilots
Set initial conditions (e.g., fuel, location, speed, etc.)	• **Extend FOM**
Alter/inject events	• Blue controller give verbal "hints", misinformation, etc • *Extend FOM*

Table 3. Possible Design Solutions for Technical Requirements

Technical Requirement	Design Alternative
Monitor and control RTI state	• MOM data / FMT
Monitor and control federates	• Talk to federate operators • **FOM extensions**
Measure federation technical performance	• MOM data • *Performance instrumentation of federates and FOM extensions*

2.4 Step 4: Develop Federation

This step involves the creation of the FOM and creation or adaptation of the federation's federates. The Taz FOM was developed via the approach depicted in Figure 5. The team focused first on the conceptual model, and training and technical requirements from the previous phases. Then, the team reviewed each federate's SOM. From these inputs, along with the technical and legacy constraints and design principles, the team drafted the first FOM from which to build consensus. The team iterated through a series of drafts as conceptual and requirement topics were addressed, thus building a finished FOM.

FOM design principles designed to take full advantage of the HLA services and to support automation were developed and followed. These principles included:

- *Execute a phased approach for building the FOM* – First the Conceptual Model (warfighter issues) was used to draft a FOM. Then, trainer requirements and technical requirements were added in stages. Finally, federation execution items were plugged in.
- *Define class hierarchies for easy future expansion* – Potential future object and interaction classes were considered so that the hierarchy could be defined to allow for new sub-classes to be added without affecting existing classes or federates.
- *Promote general attributes, especially identification enumerations, to highest levels* – General attributes were promoted to allow general-purpose viewer federates to subscribe to highest levels, thus greatly reducing (if not eliminating) impact of future hierarchy expansion.
- *Group attributes and parameters based on need for consistency* – Attributes and parameters were grouped as complex data types to ensure object temporal consistency, as well as to improve general data handling. At same time, the benefit of grouping was weighted against the limitations it places on object ownership (the whole group must be transferred) and the impacts on data throughput efficiency (the whole group must be published).
- *Use other related FOMs as a starting point* – The RPR-FOM was used for Taz as a start, particularly for content. Changes, additions, and deletions were made to support specific Taz requirements, and to adhere to these FOM design principles.
- *Consider modeling "one-time" events in the receiving federate* – One time events could be handled by having the event-initiator send and interaction to initiate receiver side modeling of the event. This design would allow significant reduction in bandwidth, but might shift the burden for modeling to federates not designed to support it, might frustrate "fair-fight" requirements.
- *Define all enumeration values in FOM* – All enumeration values were put in the FOM to provide a single place for documenting enumerations, and to allow automated tools to key off the FOM directly.
- *Define data formats in FOM* – Data formats were fully defined in the FOM (without use of "any" type), to allow automated tools and code generators to work from directly from FOM.
- *Maintain array counts explicitly* – Array counts were explicitly put in the FOM to facilitate automated tool execution and reduce receiver side processing.

In parallel, the team defined the federation policies and documented them in the Federation Agreements and Implementation Document, or FAID. The FAID is shown as a product of the FOM development process in Figure 5 and its contents are described in Figure 6.

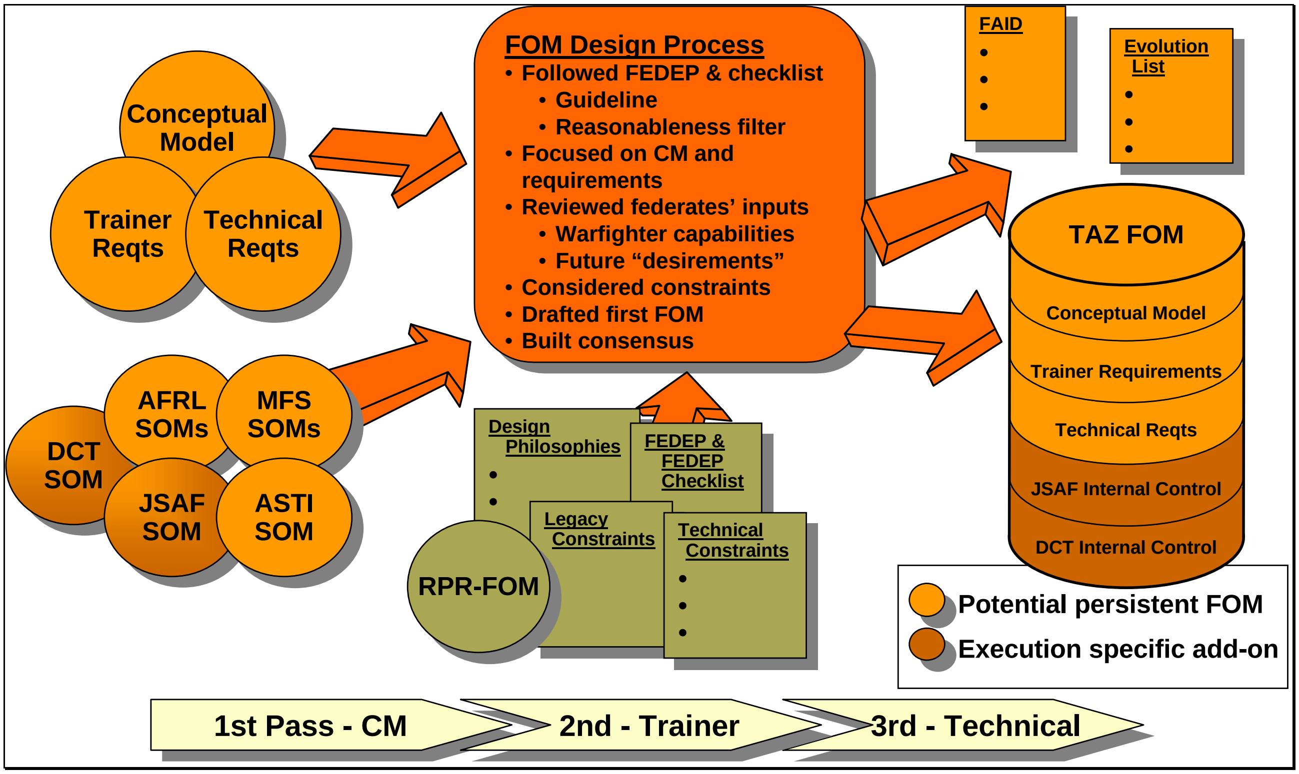

Figure 5. Tasmanian Devil FOM Design Process

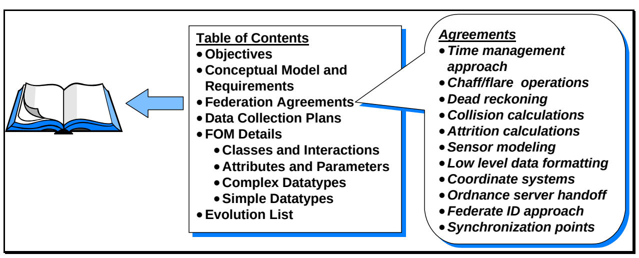

Figure 6. FAID Table of Contents

Once the FOM was completed, the next activity was to build the HLA interfaces. Both AFRL and ACETEF MFS adopted interface approaches that would allow maximum reuse across the different federates that they own. New interfaces were built for:

- AFRL F-16 simulator
- AFRL controller station
- ACETEF MFS F-18 simulator
- ACETEF MFS ordnance server
- ASTi Radio

JSAF has an agile FOM interface that includes many predefined mappings of the JSAF SOM to alternate FOMs. For this project, the JSAF developer selected the appropriate mapping to the Taz FOM, or in the cases where a predefined map did not exist, created one.

Terrain databases were identified and reused for the cockpit simulator image generators and JSAF. Based on the project scenario, a database containing the appropriate forces and scripts was developed for JSAF.

Finally, an important product of the federation design was an evolution, or "later" list, capturing all the functionality not implemented in the interest of schedule. This includes:

- Alter/inject training events
- Full MOE and MOP production, potentially including cockpit data
- Robust and reusable set initial condition interactions
- Full federate control interactions
- Measure federation technical performance
- Functional enhancements
  - Visual and environment factors
  - Aircraft datalinks
  - IFF
  - Articulated parts for entity representations
  - Chaff, flare and ECM effects modeling
  - Multi-spectral sensor capabilities (EO, IR, laser)
  - Collisions

2.5 Step 5: Integrate and Test Federation

Pre-integration tests of each federate in a stand-alone mode and three full federation integration events for each laboratory were planned. Pre-event readiness reviews resulted in some dates changes but schedule flexibility was limited by simulator availability

A lesson learned was that the simulators were not required at early events and that simulator surrogates are better suited for early integration activities.

A benefit of developing parallel federations was that alternating events between labs allowed for lessons learned at one event to be applied at the next. As a result, each laboratory was able to piggyback on the progress of the other.

The F-16 simulators and DCS at AFRL completed HLA compliance testing. Compliance testing could not be scheduled at ACETEF MFS due to conflicting schedules for simulator availability at ACETEF MFS and the compliance testing team, but that testing will be scheduled at the earliest available date.

However, total integration was not completed at either laboratory. The demonstrations were conducted as scheduled but neither Taz-Nav nor Taz-AF were as robust as the team would have preferred and there were anomalies in both federations that remain uninvestigated as of the writing of this paper.

3. Major Findings

The following findings are preliminary. A more complete assessment will follow completion of integration of Taz-AF and Taz-Nav.

3.1 HLA

Use of the HLA has been successfully demonstrated in a high fidelity, warfighter-in-the-loop air-to-air training environment. The project served as a beta-site for RTI-NG, which was just officially released in November 1999. AFRL made first use of the VxWorks version of the RTI. Both AFRL and ACETEF MFS demonstrated use of RTI-NG in a federation that included federates using other operating systems (i.e., Windows NT, Linux, and VxWorks).

RTI-NG, the FEDEP, and the supporting tools were all useful, but the team is in the process of documenting specific areas where improvements are needed.

Still to be completed is final development, integration, tuning and assessment of the federations.

3.2 FOM

A single FOM can support different services and different federates.

The aircrew distributed mission training community needs to define its own, single objective FOM. This FOM would support the community's persistent federation, which will consist of those simulators that will be routinely used and reused in different combinations to support distributed mission training. Having an objective FOM would support "plug and play" operations within the community. The FOM should be developed, tested, optimized and evolved for this community by the community stakeholders, and should provide a push for the establishment of industry standards.

An objective FOM in this domain should support not only the conceptual model, but should also support trainer and technical requirements. This would facilitate adoption of an integrated training and technical management approach across the community and further promote interoperation.

Non-persistent FOM subsets can be added temporarily to an objective FOM for a particular federation execution(s) to meet non-general federate or facility requirements. For example, the Taz FOM included non-persistent FOM add-ons to support the JSAF simulation control SOM, the VTC hlaResults™ SOM, and technical control functions at AFRL that were implemented in a custom fashion.

Objective FOM design decisions need to include not only near term cost considerations, but also life-cycle cost. A design that is best for legacy federates may not be the best design for future evolution. Additional consideration should be given to overall federation performance. Sound FOM design practices are needed to make full use of the HLA RTI services and supporting tools.

The Real Time Reference (RPR) FOM is a good starting point for objective FOM content that addresses the requirements of the conceptual model. However, improved data content, organization, and structure are required to make full use of the capabilities of the HLA. In addition, the content needs to be expanded to include additional battlespace elements such as the natural environment and C4I, and the data exchanges to meet trainer and technical requirements.

Finally, it must be noted that the same arguments for having an optimized domain-specific objective FOM apply in other domains. There will likely be occasional requirements for federates from this domain to interoperate in federations using a different FOM and, in those cases, an agile FOM interface can significantly reduce the costs of integration.

3.3 FEDEP

The FEDEP is well suited for the development of new federations from start to finish. However, a persistent federation is sufficiently different that a separate process altogether may be warranted to describe its development and execution. Important differences include the following:

- The life cycle of a persistent federation has two distinct phases. The first phase will define the overall objectives, conceptual model, trainer and technical requirements, and FOM for the persistent federation as whole.
- This phase will likely also include significant testing of the objective FOM and individual federate ability to interoperate using the FOM.
- This phase will be relatively time-consuming and should be executed with attention to the long term benefits of general and flexible design.
- This phase will be executed once, or in the case of an evolutionary federation, will be executed iteratively in a managed fashion to meet new requirements.
- The second phase will be in a steady-state mode focused on plug and play operations. In steady state, the conceptual modeling/ requirements definition step will simplify to selection from a predefined shopping list of capabilities defined by the persistent federation's conceptual model, trainer, and technical requirements.
- Similarly, in steady state, the design step will simplify to allocation of functionality to federates.
- The develop step will simplify to building of databases and "plugging-in" of federates that are ready to operate with the objective FOM
- The test step will focus on system checkout, rather than integration of new software.

3.4 Schedule

More time should have been allocated to this project, or else the first two FEDEP steps (Define Objectives and Develop Conceptual Model) should have been completed prior to project start. The team make-up was primarily technical personnel and did not include the right kind of expertise to perform the first two steps without seeking (belatedly) outside help. This lesson should be applied to team composition for future distributed mission community FOM development work.

Another factor that impeded progress was the difficulty in scheduling simulator test time. A single small schedule slip can result in long overall delays if the simulators are not available when needed. A method to alleviate this problem is to test the FOM thoroughly in a purely software environment before testing it in the cockpits.

3.5 Findings Under Construction...

As of the writing of this paper, a follow-on to the Tasmanian Devil project is planned. The current plan is for Tasmanian Devil 2000 to complete integration, and tune the federation. Tasmanian Devil 2000 will also allow the team to study and reflect on the entire process, and to fully capture lessons learned. Among some of the areas to be addressed are objective FOM design balance, federation assessment, and the use and definition of FOM agility in a persistent federation environment.

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Tasmanian Devil: An Application of the High Level Architecture in the Distributed Mission Training Domain

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Overview

- Background and Definitions
- Research Approach and Schedule
- Scenario and Federation Overview
- FOM Design Process and Philosophies
- Findings
  - FOM
  - FEDEP
  - Tools
  - Testing
- Summary

Background

- DMSO developed the High Level Architecture (HLA) and supporting tools, software and processes to support the broad DoD M&S community
- The Air Force is interested to use the HLA to meet its future distributed mission training requirements
- The Air Force and the Navy are interested in how the HLA can help support joint training
- Tasmanian Devil is a research project aimed at gaining practical experience in the application of the HLA in the distributed mission training domain

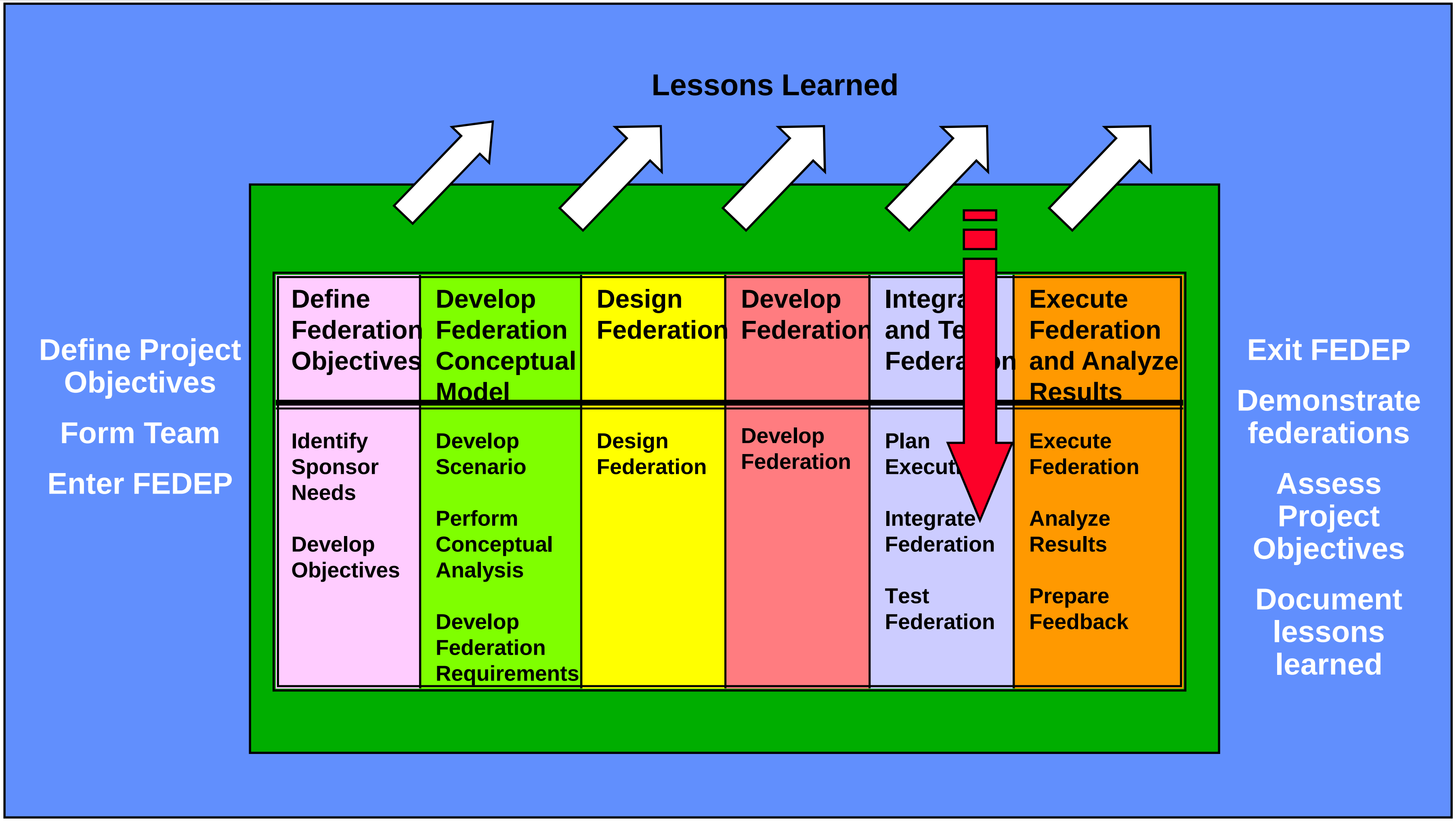
Tasmanian Devil (Taz) research federations are to provide Air Force and Navy high fidelity, warfighter-in-the-loop, mission-level training for a specific set of air-to-air tasks.

Definitions

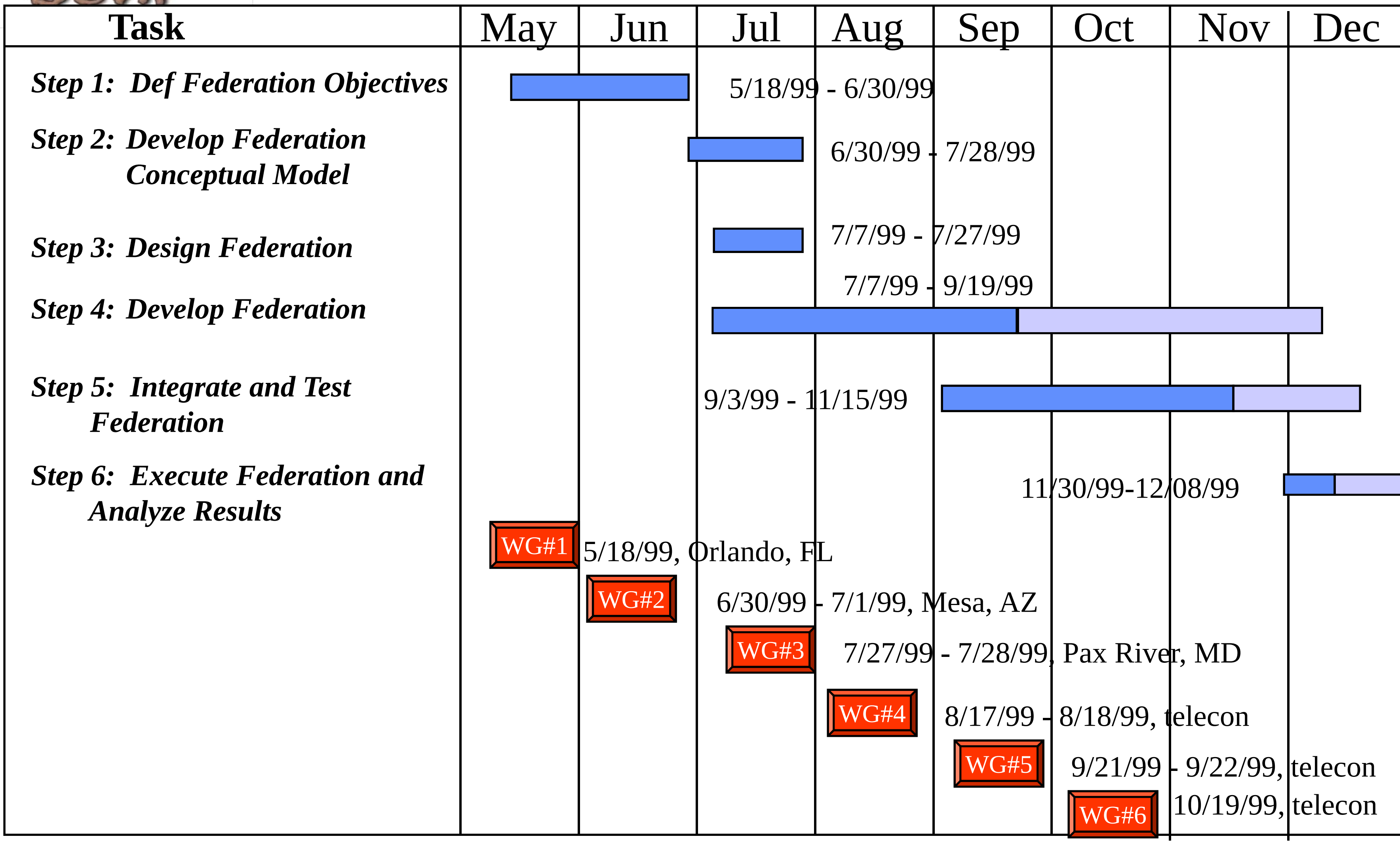
- **Persistent federation: a collection of specific federates and objective FOM used by those federates.**
  - **"Persistent" due to use/reuse over an extended period of time.**
  - **Any logical subset of the federates and FOM may be used.**
- **Evolutionary federation: a persistent federation that evolves its composition (FOM & federates) over time.**
  - **Evolution must be systematically managed to ensure configuration control and reduce adverse impact from change**
- **Objective FOM: describes all data that might be exchanged at runtime within a persistent federation.**
- **FOM Agility: federate ability to "easily" map its SOM to the FOM of a particular federation execution.**

Federations supporting the distributed mission training domain will likely be *__persistent__* and *__evolutionary__*, *perhaps using FOM agility*

Research Approach

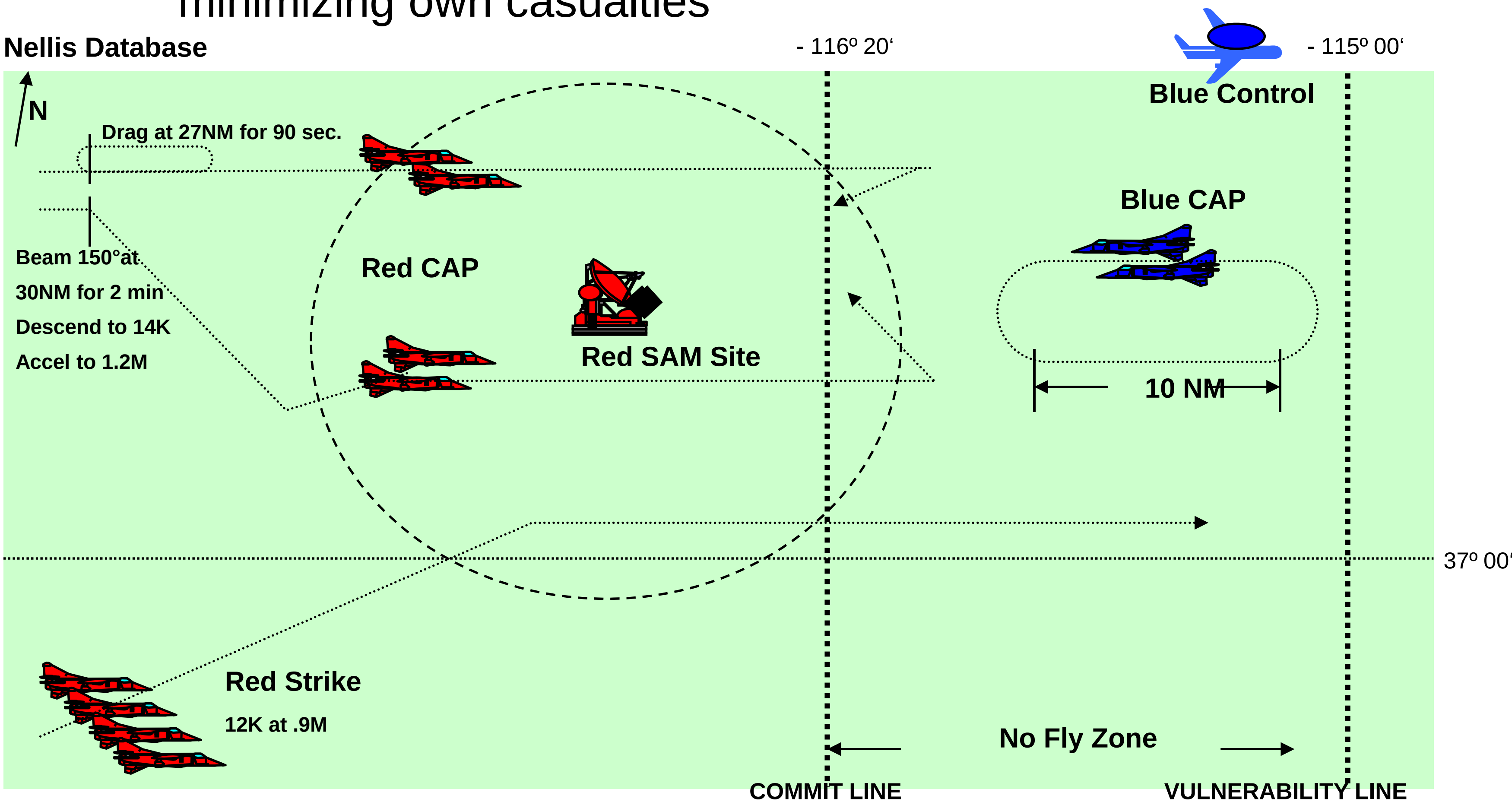


Taz Schedule



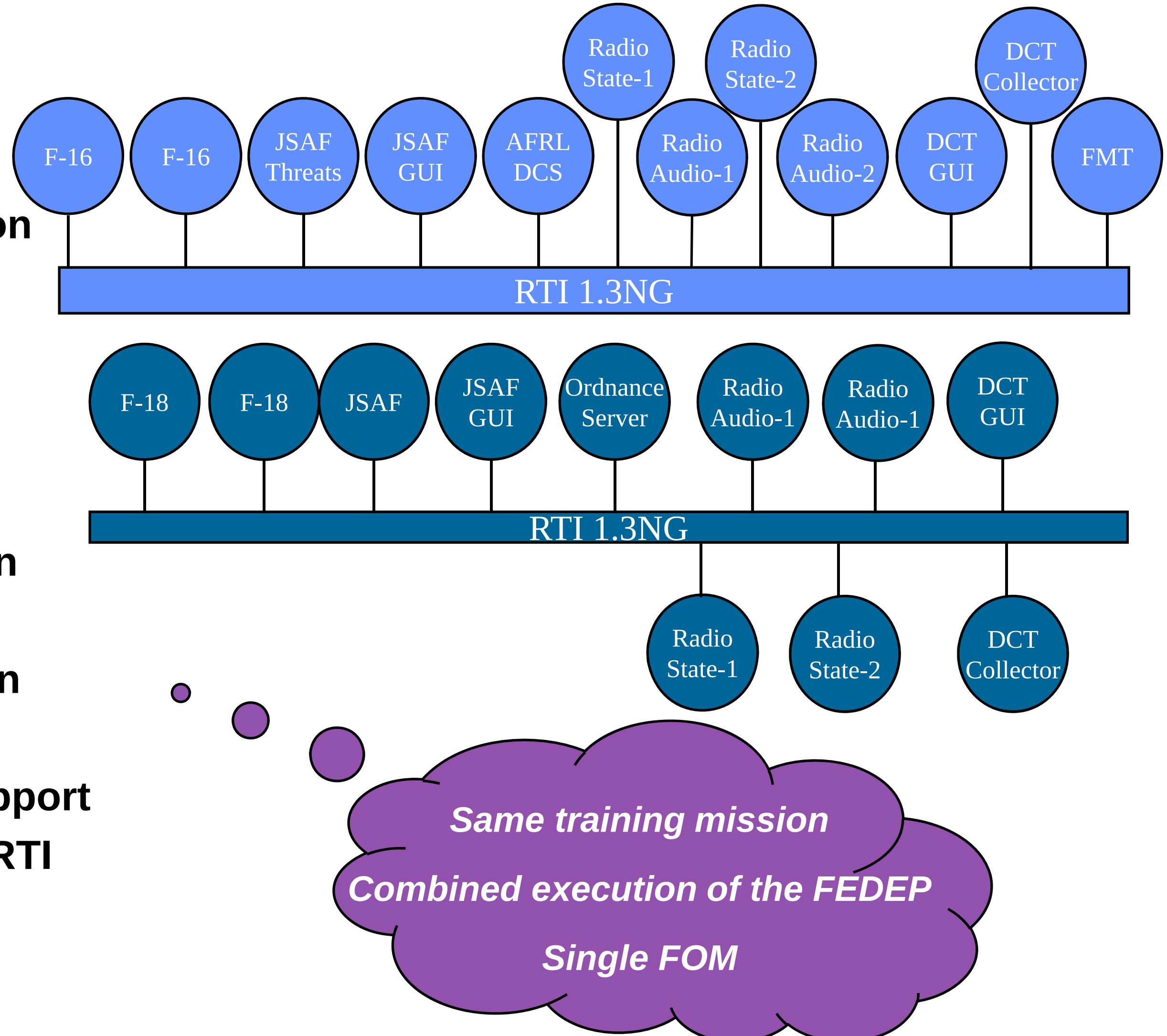
Scenario Overview

Mission: Protect friendly airspace against threat penetration while minimizing own casualties

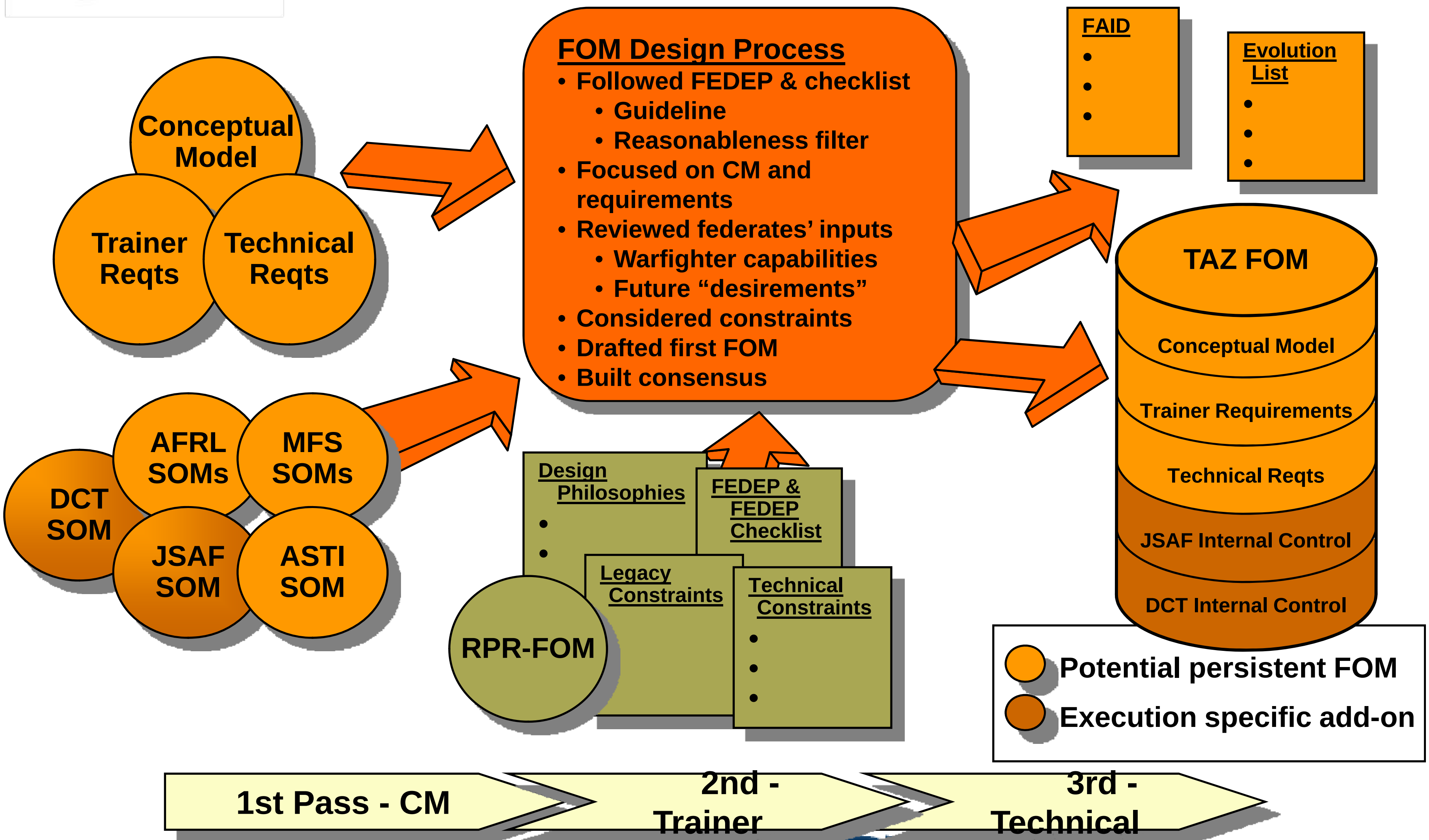


Team Members, Federates and Federations

- AFRL/HEA (Mesa, AZ)
  - 2 USAF F-16 simulators
  - Director controller station
- Manned Flight Simulator (Pax River, MD)
  - 2 USN F-18 simulators
  - Ordnance server
- LMIS
  - JSAF Combat Simulation
- ASTI
  - Radio System Simulation
- DMSO & DMSO Cadre
  - System Engineering Support
  - Various DMSO Tools & RTI
- ACC
- ASC/YW
- AFAMS



Tasmanian Devil FOM Design Process

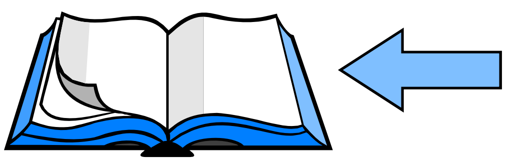


FOM Design Philosophies

- Execute a phased approach for building the FOM
- Define class hierarchies for easy future expansion
- Promote general attributes, e.g. identification enumeration, top highest levels
- Group attributes and parameters based on need for temporal consistency
- Use other related FOMs as starting point
- Consider modeling “one time” events in receiving federate
- Define all enumeration values in FOM
- Define data formats in FOM
- Maintain array counts explicitly

Federation Agreements / Implementation Document (FAID)

- **Describes Federation in more detail than FOM**
  - More semantic meaning to data flowing between federates
  - Companion / addendum to FOM



<u>Table of Contents</u>

- Objectives
- Conceptual Model and Requirements
- Federation Agreements
- Data Collection Plans
- FOM Details
  - Classes and Interactions
  - Attributes and Parameters
  - Complex Datatypes
  - Simple Datatypes
- Evolution List

<u>Agreements</u>

- *Time management approach*
- *Chaff/flare operations*
- *Dead reckoning*
- *Collision calculations*
- *Attrition calculations*
- *Sensor modeling*
- *Low level data formatting*
- *Coordinate systems*
- *Ordnance server handoff*
- *Federate ID approach*
- *Synchronization points*

Major Findings - FOM

- A single FOM can support different services and different federates
- The aircrew distributed mission training community needs to define its own objective FOM
  - supporting the community's persistent / plug&play federation
  - optimized for and evolved by this community
- Design decisions need to include near term and life-cycle cost and performance considerations
  - Sound design practices to make use of HLA RTI services and supporting tools, as needed
  - Trade off legacy federates needs vs. future evolution
- FOM subsets (persistent or not) added for particular federation/federate needs or execution goals
  - to meet requirements of particular federates and/or facilities

Major Findings - FOM

- Technique for abstracting or filtering view of FOM would be useful
  - Often hard to follow / find things when FOM is cluttered with extra, federate specific class and interactions
  - FOM tools should consider some type of mechanism to allow for filtered views of FOM
- Even with an objective FOM, there will likely be need for FOM agile interface techniques
  - Reduce costs of integration into a test or exercise federation
  - Can help reduce impacts of FOM evolution
- Taz FOM entity identification approach
  - We used new, structure-independent enumeration in order to include directly in FOM
  - Codifying DIS enumeration might have been possible, but...

Major Findings - FEDEP

- **Checklist for persistent federations would be useful**
  - Gives impression that a new FOM must be developed for each federation execution
  - FEDEP does allow that FOM development may simply mean using an existing FOM
- **FEDEP activities under-scoped in project schedule**
  - Of 7 month schedule, first 2 months spent defining objectives and conceptual model, and in mutual discovery
- **FAID critical to conveying expected interoperations**
  - But, must be agreed to and understood
  - No substitute for continual dialogue
- **Trainer/technical requirements must be addressed**
  - Need to identify these requirements and facilitate them

Major Findings - Tools

- RTI NG (used beta and first release)
  - Successful with RTI NG on VxWorks platform (along with mixed other operating systems
  - RTI NG memory requirements on VxWorks platform are high
- OMDT
  - A real workhorse, but user interface awkward at times
- Visual OMT
  - Better user interface, but has its own limitations
- FEPW (used early beta versions)
  - FOM updates required data to be re-entered
  - Enumerated datatypes size information not included in FOM

Major Findings - Tools

- **FMT (used multiple beta versions)**
  - Some difficulty with installations and execution
  - Very useful tool during early phases of integration, gave great insight into what federates were doing
- **Test Federate**
  - Invaluable early in integration
  - Better interface and operations are required
- **DCT / hlaResults**
  - Captures object updates and interactions for integration tests
  - Invaluable in gaining insights into federation MOE data
  - Replay capability developed and demonstrated in lab

**DMSO Tools helped the project be successful,
while also showing what to look for "off the shelf".**

Major Findings - HLA Testing

- **HLA compliance testing value**
  - Passed tests with little of planned functionality operational
  - Hard to explain compliance tests meaning to management
  - Passing tests says more about ability to create HLA federates than about functionality (or anything about interoperability)

Results, Conclusions, ...

- **Use of the HLA has been successfully demonstrated**
  - First step for distributed mission training environments
  - RTI NG under VxWorks and with mixed operating systems
  - But still some tuning and assessments to be done
- **HLA RTI NG, FEDEP processes and supporting tools were all useful, with some suggested improvements**
  - Need to better address needs of persistent federations
- **Next Phases of Tasmanian Devil will address federation stability and performance issues**
  - FOM changes in work
  - Demonstrations planned for Summer 2000
  - Detailed “interim” report in work